Canada. Interdepartmental
Skilled Manpower Training
Research Committee
Report

RESEARCH PROGRAM ON THE
TRAINING OF
SKILLED MANPOWER

No. 6

OUTLINE OF TECHNICAL TRAINING IN THE UNITED KINGDOM

Department of Labour, Canada,
in co-operation with federal and
provincial government agencies and
other groups

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Foreword

The need for a comprehensive review of the technical education system in the United Kingdom has been raised several times in the course of the research work in skilled manpower training needs conducted during the past two years by the Canadian Department of Labour in co-operation with other federal and provincial government agencies. Such a review, it was felt, would provide information permitting comparisons to be made between the Canadian and United Kingdom systems of technical education and would possibly suggest ways in which the Canadian system might be improved.

This report on "Technological Education in the United Kingdom" has been prepared by Mr. W. Graham Craig, who was employed by the Department of Labour in the summer of 1957 to assist in the Skilled Manpower Training Research Program. Mr. Craig until recently was an instructor at the Royal College of Science and Technology and the Scottish College of Commerce, Glasgow, a position which has provided him with a knowledge of the facilities for technical education in the United Kingdom.

A draft of this report was sent to officials of the United Kingdom Ministry of Education who kindly suggested a number of changes and provided some additional and more recent data. The Canadian Department of Labour, of course, assumes full responsibility for the report in its present form.

The report deals with the efforts made by the Government of the United Kingdom to cope with the need for more technical and scientific manpower through an expansion and improvement of the educational institutions concerned with technical training, both elementary and advanced. It describes in detail the organization and functions of the various types of technical training institutions found in the United Kingdom. In discussing the regular school system, the report points up the differences between the grammar school, the secondary modern school and the secondary technical school. Of particular interest is the section on the "Technical Colleges" and their role in the field of advanced technical education. Also of special interest is the system of granting certificates and diplomas, such as the ordinary and higher national certificate, which enable workers in industry to progress to the skilled, technician and professional levels. The report also includes a section on the universities and their contribution to the training of scientific manpower.

November 1958 Department of Labour, Ottawa

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I INTRODUCTION

As in every other country of the world, the inexact definition of the characteristics of skill and knowledge which distinguish the craftsman from the technician, and the technician from the technologist, has created difficulties in the analysis and classification of the scientific manpower which is available to the United Kingdom and in the assessment of the sources which are likely to provide material both in the near and more distant future for technological education and training at its most advanced levels.

It is of interest, therefore, to note the following definitions which were embodied in a Report presented to Parliament by the Minister of Education in February 1956, on the subject of "Technical Education":

1. "A Technologist has the qualifications and experience required for membership of a professional institution. A Technologist has studied the fundamental principles of his chosen technology and should be able to use his knowledge and experience to initiate practical development. He is expected to accept a high degree of responsibility and in many cases to push forward the boundaries of knowledge in his own particular field."

2. "A Technician is qualified by specialist education and practical training to work under the general direction of a Technologist. Examples of Technicians in the factory are assistant designers and junior ranks of management on the shop floor".

3. "Craftsmen represent the skilled labour of manufacturing industry and account for more than one-third of its manpower. With the growing complexity of machines and the introduction of new materials it becomes all the more necessary for them to appreciate not only the how but also the why of the work they do".

Having thus defined the three main categories of skilled personnel who are the object of technical education, this Ministry of Education Report proceeds to outline the principal qualifications by which the members of each of these categories may be identified.

1. Technologists

In the case of technologists, the possession of:

(a) An Ordinary or Honours degree of a British university; or

(b) The Diploma or Associateship of a Technical College in the United Kingdom.

2. Technicians

As far as technicians are concerned, the possession of any one of the following:

(a) The Ordinary National Diploma or the Higher National Diploma;

(b) The Ordinary National Certificate or the Higher National Certificate, which are awarded jointly by the Ministry of Education or the Scottish Education Department and the professional institutions concerned.

(c) An appropriate Certificate of the City and Guilds of London Institute at technician level.

3. Craftsmen

Craftsmen are distinguished by the possession of one or other of the following qualifications:

(a) Intermediate or Final and Full Technological Certificates of the City and Guilds of London Institute.

(b) Certificates of the four Regional Examining Unions which work in co-operation with the City and Guilds of London Institute and hold examinations of a similar level at the Intermediate stage and higher stages.

(c) Certificates awarded by various professional and trade organizations.

As a general classification and evaluation of the many different types of technical qualification which are obtainable in the United Kingdom, the list may prove of service in the consideration of what follows.

II SCHOOLS

In view of the complexity of the system of technological education which exists in England and Wales, and the very large numbers of institutions which provide technical training in some form or other, at both the most elementary and the most advanced levels, it is, perhaps, the logical approach to any outline of the subject to provide a brief summary of the pattern of school education as it exists in these countries.

Children clearly cannot be provided with technician nor technological training while in compulsory full-time attendance at primary day-schools, but a measurable part of their basic training in craftsmanship is, nevertheless, received by them in institutions managed and controlled by local education authorities, either in their later years of compulsory day-school attendance or in the years immediately following their statutory release from such attendance. In the eyes of the Government, too, the children constitute the basic pool from which will be drawn the manpower available to the nation for scientific and technological training, either in the immediate or in the more distant future.

School education is of course, from the governmental point of view, the concern of the Ministry of Education. The Ministry exercises powers under a large variety of Acts of Parliament. The Education Act, 1944 (sometimes known as the Butler Act) is the most important statute in recent years affecting education and the duties of local education authorities in regard to it, although minor amending acts were passed in 1946, 1948 and 1953.

In the discharge of these powers the Minister of Education issues his main requirements in the form of statutory regulations and in circulars addressed to local education authorities and other bodies.

England and Wales are divided for the purposes of educational administration into 146 local education authorities, which consist of 61 administrative counties, 83 county boroughs, 1 joint board, and the London County Council.

The Education Act, 1944, divides general school education into three stages, which are briefly described for the sake of logical exposition, although not all are strictly relevant to the purposes of the present memorandum:

1. Primary Stage

(a) Nursery Schools

A local education authority is under a statutory obligation to provide nursery schools for all children under the age of five who reside within its area, provided the parents of the children request the authority to provide such nursery accommodation.

If the parents of the children within its area do not demand the establishments of nursery schools, on the other hand, or if an unreasonably small number of parents demand such accommodation, the local education authority may decide not to do so. In such circumstances the power of the local education authority is entirely discretionary, subject, of course, to the advice and suggestion of the Ministry of Education.

(b) Infant Schools

Attendance at day-school is compulsory in the United Kingdom at the age of five years and local education authorities are under a statutory obligation to provide schools for such children residing within their areas, and to ensure their attendance thereat, whether or not there is a demand by the parents of the children for the establishment of such infant schools.

(c) Junior Schools

As in (b) above, local education authorities are under a statutory duty to provide these schools, which are designed for children between 8 and 11 years of age.

In the majority of areas both infants and juniors are accommodated within the same school building, but in other districts separate schools exist.

Primary education is, inevitably, general and non-vocational in character. Children are taught reading, writing, and numbers as soon as they are ready to assimilate the elements of knowledge. There is no uniformity of teaching method throughout the country, but the underlying objective is to relate the various subjects as closely as possible to each other and to the child's experience of life.

For children between the ages of five and seven the main concern nowadays is to provide an environment adapted to promote the healthy development of body and mind. Formal work takes second place, and the importance of music, drawing, handwork, nature study, dramatization and speech training is stressed. In the more advanced primary classes the promotion of physical, intellectual and moral growth continues to be the primary aim. In the field of formal instruction, emphasis falls on the acquisition of a good command of the mother tongue both in speech and in writing, on the cultivation of reading as a source of information and pleasure, and on the ready and accurate performance of operations in arithmetic. Art, music, and handicrafts are taught in order to cultivate the aesthetic sensibility and to develop manual skill; and in such subjects as nature study, history, and geography, the aim is to enrich the children's experience and lead to the formation of desirable interests.

The actual framing of the detailed courses is left to the individual school authorities concerned although in some areas standard schemes of work have been drawn up by panels of teachers. The schemes of work must, of course, be approved by H.M. Inspector in charge of the District in which the school is situated.

2. Secondary Stage

Minimum secondary education is for children aged 11 to 15 years. The Government of the United Kingdom has declared its intention to raise the minimum school-leaving age from 15 to 16 years when the necessary accommodation has been obtained for the additional influx of scholars and when staffing arrangements have achieved a more satisfactory ratio to the total number of children already in attendance at day schools.

Three distinct types of Secondary School are recognized by the Education Act, 1944:

(a) Secondary Grammar Schools

These schools provide an academic and non-vocational education to the age of eighteen. Included in their curriculum, however, are practical subjects such as handicraft, domestic science, needlework, art and music. In practice there is considerable freedom in regard to the planning of the instruction and in some schools special courses are provided which are related to the needs of the pupils who will enter industry or commerce.

(b) Secondary Modern Schools

These schools form the largest group of secondary schools. They give a general education with a practical bias, closely related to the interests and environment of their pupils.

(c) Secondary Technical Schools

The secondary technical schools are the smallest group and offer a general secondary education with a bias in the later years towards one or other of the main branches of industry, including agriculture.

The Education Act, 1944 enacts that all forms of secondary education are of equal status and the establishments in which they are given are of equal rating.

Each local education authority determines its own manner of selecting scholars for admission to the three different types of secondary school. The kind of secondary education a child is given usually depends on the results of a test taken at the age of 11, although in some areas it is possible for children who are recommended by their head teacher to take the test at 10 years of age. The procedure followed is laid down in the promotion scheme framed by each local education authority. The actual operation of the promotion arrangements is supervised by a Promotion Board, which normally consists of representatives of the Education Authority, the Director of Education, and representatives of the head teachers and staffs of both primary and secondary schools. Pupils are allocated to the various types of secondary courses according to their fitness to profit from them, assessed on the basis of evidence derived from teachers' estimates of attainment, intelligence tests and attainment tests, including, of course, the test already referred to at the age of eleven. Due regard must be had to the special aptitudes of the pupil as shown in his earlier school record of work and to the wishes of the parents. Under the Education Act an appeal may be made to the Minister in the event of a dispute between the Education Authority and the parent regarding a pupil's ability to benefit from a particular course, and also for the reconsideration of original allocations where transfer to another course subsequently appears desirable.

In 1951 the General Certificate of Education was introduced by the Minister of Education, acting on the recommendation of the Secondary School Examinations Council which is an advisory body, including representatives of the universities, the teaching profession, and local education authorities.

The General Certificate of Education replaces the former "school certificate" which was generally awarded at the age of 16, and the "higher certificate" which was awarded after a second examination of

those who stayed on at school until a later age. Formerly the certificates were awarded following examination in all the subjects of a group, but the General Certificate of Education may be awarded in single subjects, thus permitting a piecemeal accreditation of courses.

Nine examining boards connected with the universities and one national board are responsible for conducting the examinations. Some of the examining bodies conduct examinations for the General Certificate of Education overseas; but there are, of course, separate conditions for candidates in such circumstances.

The main features of the General Certificate Examination are that:

(a) papers are set at three levels--ordinary, advanced and scholarship--and a certificate is given for a pass in one or more subjects. Further passes at higher levels or in other subjects may be added to a certificate on further study by a candidate;

(b) all subjects are optional and no "minimum" or "group" requirements are imposed for the award of the certificate;

(c) most candidates are at least 16 years of age on the 1st of September of the year in which they sit for their examinations, but a boy or girl may sit for the examination at an earlier age at the discretion of his or her headmaster or headmistress.

The candidate can choose his subjects from some 40 or more that may be taken at the ordinary level and about 30 at the advanced or scholarship levels. Besides the usual academic subjects he may elect to take art, music, handicraft, or domestic, commercial or technical subjects. In the subjects last mentioned both written papers and practical tests are required.

The majority of pupils at grammar schools and public schools,(1)

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(1) There is no exact definition of the term "public schools", but it is generally used to denote a boarding school of the grammar school type. The leading public boarding schools tend to recruit their pupils on a national, rather than a local, basis. Few of them receive any public financial aid. Generally they charge higher fees and admit children at a somewhat later age (about 13) than do other grammar schools. Some of them are very old foundations, as in the case of Eton which dates back to the 15th century, while others, such as Stowe, were founded in the present century.

and some pupils from other secondary schools, take this examination. Passes at appropriate levels in suitable groups of subjects satisfy the preliminary educational requirements of the universities and many professional bodies.

3. Further Stage

Further educational facilities, at the moment of writing, include all types of provision for education, whether academic or technical, after the minimum school-leaving age of fifteen years has been attained, other than by continuation at day school. As already stated, it is the intention of the Government to raise the minimum school-leaving age to sixteen years when deemed expedient and having regard, among other things, to the needs of industry.

The main divisions of the further education stage for the purposes of this memorandum are:

(a) County Colleges

The Education Act, 1944, provides that, in due course, as from an appointed date, all boys and girls in England and Wales who give up full-time education before the age of 18 will be required to attend an institution to be called a county college, for at least 44 whole days or the equivalent each year until they attain the age of eighteen. It is intended that county colleges shall take their place within the environment of local colleges of further education and that these colleges shall also provide full-time vocational courses for young persons under 18, as well as part-time day and evening courses of all kinds, both vocational and general.

When County Colleges are established throughout the country a good deal of the vocational work which is now undertaken in the evening will be transferred to the day-time. It is thought, however, that this will involve no reduction in the total amount of evening studies which are, at present, being carried on throughout the country, as the demand for education at all times is almost certain to increase rather than decrease.

(b) Technical Colleges and Schools of Art and Commerce

A full discussion of these colleges is given later in this report.

(c) Evening Institutes

Evening Institutes provide both vocational and recreational classes in a very wide range of subjects. Many such institutes are accommodated in day-school buildings, but other suitable buildings in the district are often used instead.

The whole field of further education in this connection contains a great amount of voluntary activity and the work of bodies other than the local authorities and the Ministry of Education.

(d) Adult Education

A great diversity of activity also exists in this department of further education, although, in general, the subjects of study are liberal rather than vocational in character. Voluntary bodies also co-operate to a large extent with local education authorities in providing these facilities. The subjects which are of main interest to adult students are usually literature, foreign languages, social studies, philosophy, religious studies, art, music, drama, and other associated departments of general education.

Voluntary and Independent Schools

So far allusion has been made exclusively to the system of school education which is provided by the network of local education authorities throughout England and Wales, acting under powers conferred by statute. But voluntary and independent bodies still continue to play an important part in the education of British schoolchildren. Under the Education Act of 1944, however, it is perhaps true to say that the State is assuming a greater degree of control over such institutions than it did formerly.

Voluntary schools are schools which have been established by a voluntary body, such as a particular religious denomination, but which are maintained, in modern times, wholly or partly by local education authorities. Over a third of the schools maintained by local education authorities in England and Wales are voluntary schools and the majority of these are Church of England primary schools.

Under the Act, if the managers of such a voluntary school are able to raise half of the funds which are required for the cost of alterations, improvements and external repairs to the school building, to conform to the modern standards of the Ministry of Education, the

school will be allowed to remain under their partial control and will be classified as an "aided school". Denominational religious instruction may still be given in aided schools, subject to the right of parents to request that their children be instructed in accordance with the agreed syllabus in general religious instruction which operates in the ordinary schools of the particular local education authority. In the aided school, moreover, only one-third of the school managers are appointed by the local education authority, the others being appointed by the voluntary body itself. The school managers invariably reserve the right to appoint and dismiss their own teachers.

If the managers of a voluntary school, on the other hand, are in a position to raise 75% of the moneys required for the modernization of their school buildings, the school will be regarded as a "special agreement school", and the management of the school will remain virtually independent.

In the event that the managers of the voluntary school are unable to raise the money necessary for rebuilding or modernizing their school, the school becomes a "controlled school" under the Act of 1944, and the school passes to a large extent under the control and management of the local education authority. The authority appoints two-thirds of the school managers, and also has the power to appoint and dismiss teachers.

The Act contains provision for preserving any condition in the original foundation of the voluntary school regarding the form of denominational instruction which is to be provided therein. Such denominational instruction may be given for not more than two periods a week to children whose parents desire it. All other religious instruction must conform to the agreed syllabus for the ordinary schools of the local education authority within whose area the school is situated.

The independent status of many voluntary schools is, at the time of writing, in a position of some doubt. Owing to the exacting requirements of the Ministry of Education in regard to classroom accommodation, recreation facilities, and staffing arrangements, many governing bodies fear their financial inability to maintain the necessary standards and thus to discharge their functions to the satisfaction of the Ministry.

In England and Wales at 31st December 1956, of the 9,193 voluntary schools then in existence, 4,213 had been given controlled status and 4,754 aided or special agreement status. The total number of voluntary schools whose status had not been determined at that date was 226.

Direct Grant Schools also continue to function in both England and Wales. These schools occupy a semi-independent position. While

they receive money grants direct from the Ministry of Education, they are run and managed by their own independent Boards of Governors, including, however, representatives of the local education authority.

A further class of school which is outside the control and management of local education authorities in England and Wales, is the independent school. There are many different types of independent schools, some of which owe their recognition to historical accident, but the largest and most important kind of independent school is known as the "public" school. Many such public schools date from the sixteenth century and all are controlled by their own Boards of Governors. In general, the public school is characterized by a high staffing ratio and a high proportion of pupils doing advanced work. Independent schools form about 15 per cent of all schools in England and Wales and about 8 per cent of all schoolchildren attend them.

Vocational Education in the Secondary Schools

As far as schoolchildren are concerned, therefore, vocational training in its most elementary form begins at the age of eleven. While children are allocated among the three different types of secondary school which have already been mentioned at the age of eleven, re-allocations take place two years later if the original selection has been proved to be unsuitable to the particular aptitudes or interests of the pupil concerned. There are many such re-allocations.

The three main types of secondary school (grammar, technical, and modern) take about 20 per cent, 5 per cent, and 75 per cent of the 11 to 16 age-group respectively, although the proportions naturally vary from one area to another according to local circumstances and preferences.

At present secondary technical schools provide a two- to three-year course on pre-vocational lines, although in the future it is hoped to provide a full length secondary course. In a number of schools fourth year intensive courses are provided at the end of the normal three-year junior secondary course.

Secondary technical courses are provided in engineering, building, textiles, housewifery, catering, commerce, art, and agriculture. The three-year course generally includes such subjects as woodwork and metalwork, technical drawing, and applied mechanics, which are considered to be subjects of high educational value as well as having a strong appeal to adolescents.

The official summary of the three-year course in woodwork, as set out in the publications of the Ministry of Education, is as follows:

Woodwork

Practical

(a) A training in the common methods of shaping and joining timber.

The common methods of shaping referred to are:-

Sawing--with and across the grain, through and stopped;

Planing--surface, edge and end;

Chiselling--with, across and inclined to the grain;

Boring;

Spokeshaving.

The common joints envisaged are:-

Housing--through and stopped;

Rebate (as in box construction);

Half check or half lap--dovetailed, through and stopped;

Halved or cross;

Mortise and tenon--plain, haunched without and with a groove and with a rebate;

Dovetail--plain and lapped (as in drawer construction).

(b) The making of three typical pieces of constructive work--stool or table construction, frame construction, box construction.

(c) Individual work.

Instruction and practice should be given in:-

(i) simple wood turning (faceplate and between centres) in the second and third years;

(ii) the setting of a plane and the grinding and sharpening of chisels and plane irons in the third year.

The relative instruction is, according to the Ministry, best dealt with by short talks and discussions, supplemented by brief notes, at appropriate intervals throughout the course.

The relative instructions include:

The setting out of work and the sequence of the common operations;

Tools: names and uses;

Simple differentiation between hard and soft woods;

The familiar timbers of the school workshop--main characteristics, relative costs;

Brief reference to tree structure in relation to timber.

Fundamentals of natural and artificial seasoning;

Types of finish for the common woods, and procedure in finishing;

Glue--types, properties, origin, manufacture, preparation and use;

Nails and screws--types and uses;

Names and applications of the common joints.

In the subject of applied mechanics the official summary of the three-year course is as follows:

Applied Mechanics

Principle of moments:--simple applications.

Centre of Gravity:--applications to stability.

Applications of the principle of moments introducing the centre of gravity; reactions of beams simply loaded.

Friction:--effects; proportional to reaction; independent of area of surfaces. (coefficient of friction need not be specifically mentioned).

Work:--simple examples.

Machines:--velocity ratio, mechanical advantage and efficiency.

Power:--horse-power; simple problems.

Triangle of forces, resultant and equilibrant of two concurrent forces:--simple applications including the inclined plane.

Rectangular components of a force:--simple applications including the inclined plane.

These two summaries give a fairly close indication of the standard of work which is attained in secondary technical schools, and while the official recommendations are not implemented in full and with complete uniformity throughout the entire country, most secondary technical schools approximate very closely to them.

In 1952-3 about two-thirds of the secondary technical schools then in being were still housed in the premises of further education establishments. There are many arguments both in favour of and against the accommodation of secondary technical schools in technical colleges, but in the view of the Ministry of Education a secondary technical school should have separate buildings of its own and a staff which combines academic ability with industrial experience.

III TECHNICAL COLLEGES

Technical colleges in the United Kingdom provide instruction in all recognized forms of technology. Apart from the wide field covered by mechanical, electrical, civil, and aeronautical engineering, courses of instruction are conducted in architecture, building, textiles, mining, plastics, and many forms of applied physics and chemistry. Students from almost every type of industry can be found in the major technical colleges of the country.

There is a considerable variation in the ages of students. Full-time day students normally range from 16 to 21 years of age or more, while the ages of part-time students are more diverse. Students attending evening courses only are noticeably older as a group, many taking refresher or even post-graduate courses. Individual colleges inevitably vary in their age groupings according to their local circumstances. As a rule, however, a higher age group is in attendance at a regional college than at one of its contributories or at a local technical college.

In England and Wales some 300 technical colleges (other than art colleges) provide full-time courses for students, while in addition some 250 technical colleges provide courses for part-time students only.

Of the total number of technical colleges, about 150 give instruction in one or more of the technologies at an advanced level: that is to say, to Higher National Certificate standard.

Most colleges offering advanced courses also undertake work at other levels, but they are tending to relegate the more elementary work to other institutions, and it is the policy of the Government that this tendency should continue.

Technical colleges in the United Kingdom are broadly of four different types: namely, local, area, regional, and Colleges of Advanced Technology. In addition, a specific form of technical college exists in the National Colleges which have been established by the Government in certain technologies.

Recent Statistics

While it is true that the greater part of the instruction at technical colleges continues to be given on a part-time basis, the

number of students in full-time attendance at such institutions has increased in recent years to an extent hitherto unknown in the history of the country.

Table I shows the growth which has taken place in the numbers of both full-time and part-time students in attendance at Grant Aided Establishments of Further Education since the conclusion of the Second World War. It is the enrolment at these centres which the Government regards as the key to future resources of technical manpower likely to be available to the nation.

Table I: Number of Students in Grant-Aided Establishments of Further Education[1]

England and Wales

000's

	1937-38	1947-48	1951-52	1956-57
Full-time.....	20	47	54	76
Part-time day.....	85	222	334	469
Evenings only.....	1,203	1,536	2,031	1,960
	1,308	1,805	2,419	2,505

1 These figures include enrolments at all polytechnics, technical colleges, technical institutes, colleges of technology, art and commerce, colleges of further education, colleges and schools of commerce, colleges of art, schools of art and crafts, as well as a miscellaneous group of institutions which are incapable of sub-classification.

Tables II and III reveal the importance of the part played by technical colleges and other establishments of further education in the educational system of England and Wales. They show the percentage of the population aged fifteen to aged twenty, who in 1956 were in attendance at school or at universities, training colleges for teachers, colleges of technology, commerce or art, or evening institutes.

Table II: Boys

(Percentage of Population at Various Age Levels)

Age	Schools	Universities	Teacher Training Colleges	Technical, Commercial and Art Colleges and Evening Institutes			Total
				Full-time	Part-time Day	Evening only	
20	-	4.5	0.5	0.9	5.8	8.1	19.8
19	-	2.8	0.1	0.9	8.3	10.2	22.3
18	4.3	1.3	0.1	1.1	11.6	12.8	31.2
17	9.6	-	-	1.2	19.3	20.8	50.9
16	17.9	-	-	1.4	21.1	25.8	66.2
15	33.5	-	-	1.3	15.3	25.4	75.5

Table III: Girls

(Percentage of Population at Various Age Levels)

Age	Schools	Universities	Teacher Training Colleges	Technical, Commercial and Art Colleges and Evening Institutes			Total
				Full-time	Part-time Day	Evening only	
20	-	1.6	1.6	0.4	0.5	8.0	12.1
19	-	1.2	2.6	0.5	0.8	9.6	14.7
18	2.0	0.7	1.5	0.8	1.7	12.5	19.2
17	7.6	-	-	1.5	4.8	19.2	33.1
16	16.4	-	-	2.5	5.8	23.0	47.7
15	32.9	-	-	2.7	4.7	23.5	63.8

Future Objectives

That a continuing shortage of scientific manpower was likely to persist in the United Kingdom for many years to come was recognized soon after the conclusion of the Second World War. Its underlying cause

was the accelerating pace of economic, political and technical change in the modern world; and its most important manifestation the competition, both within and between industrialized countries, to apply the fruits of new scientific and engineering discovery to production and commerce.

The first of many post-war reports on the need of the nation to increase its scientific manpower and to develop its facilities for technical education was issued by the Percy Committee on Higher Technological Education in 1945. The report recommended, inter alia, that full-time technological courses of university degree standard should be established at a selected number of technical colleges. These selected technical colleges should be "developed into responsible academic institutions, performing a national function". A few National Schools of Technology should, moreover, be established to meet the needs of small but highly important and specialized industries.

The Barlow Committee, which was appointed in 1945 to consider the question of scientific manpower, published its report in 1946. The report recommended that the output of science graduates should be doubled within the next ten years and that, in discharging this task, the universities should be assured of the necessary assistance from the Exchequer. The committee also endorsed the recommendation of the earlier Percy Report that full-time courses of university degree standard should be established at selected technical colleges.

The universities in fact implemented the main recommendation of the Barlow Committee within four years, instead of the ten years which they had been allowed by the report, an achievement which was all the more remarkable in that it involved no lowering of educational standards.

Towards the end of December 1955, the Minister of Education undertook in the House of Commons to make an early announcement of his proposals for improving and extending facilities for technical education.

These proposals were embodied in a White Paper on "Technical Education", which was published on 29th February 1955, and which gave details of the Government's plan for a five year programme of development.

In England and Wales the initial objectives were to increase from about 9,500 to some 15,000 the annual output of students from advanced courses at technical colleges, and, as part of a proportionate increase at the lower levels, to double the number of 355,000 young people released by their employers during 1954-55 for part-time courses during the day.

The Government also considered that certain colleges, to be known henceforth as "Colleges of Advanced Technology", should concentrate exclusively on advanced work, which should consist mainly of full-time and sandwich courses at the technological level.

The White Paper rejected the contention that those colleges originally instituted by local authorities could not be successfully administered at that level, and refused to consider the administration of such colleges as a function of the central government.

Types of Colleges

Following on this White Paper, the Ministry of Education issued Circular 305 on "The Organization of Technical Colleges" in June 1956. The circular stressed that the object of the Government's policy was to provide a framework for expansion, based on the existing structure, which would be flexible and would take account both of the limiting factors, such as the supply of teachers with the highest qualifications, and of the need to provide courses within reasonable reach of the students and industries concerned.

Towards this end, the circular distinguished between four different types of technical colleges:

(1) "Local" Colleges, which provided courses, mainly part-time, up to the level of the Ordinary National Certificate or its equivalent.

Many new colleges of this kind would be required as part of the programme of doubling the number of students released for part-time day courses and of increasing the supply of technicians and craftsmen.

(2) "Area" Colleges, which provided, in addition to local college courses, varying amounts of advanced work, mainly of a part-time nature.

The general aim, so far as Higher National Certificate and similar courses are concerned, should be to strengthen and expand the existing area colleges, where such courses are already provided.

(3) "Regional" Colleges, which provided a substantial amount of advanced work, including in particular full-time and sandwich courses.

(4) "Colleges of Advanced Technology", which would deal exclusively with work at the highest level.

Colleges of Advanced Technology

To be classified as a "College of Advanced Technology" an institution had to satisfy the exacting requirements set forth in the appendix to the circular. These conditions involved such considerations as the scope and standards of the work already performed at the particular college, its constitution and form of governing body, and its standards of staffing and accommodation.

It is significant that none of the technical colleges then in existence fully satisfied the conditions of the circular.

Nevertheless in June 1956, the Minister of Education announced that, after negotiation, he proposed provisionally to designate eight colleges as "Colleges of Advanced Technology". These colleges were:

The Royal Technical College, Salford,
The Technical College, Bradford,
The College of Technology, Loughborough,
The College of Technology, Birmingham,
The Welsh College of Advanced Technology, Cardiff,
Battersea College of Technology, London,
Chelsea College of Science and Technology, London,
Northampton College of Advanced Technology, London.

He hoped to designate two more colleges later, one in the south-west at Bristol, and the other in the north-east, where no existing college was immediately suitable for designation.

By the end of 1956 all but three of the eight colleges already mentioned had been officially designated by the Minister as "Colleges of Advanced Technology", and the remainder since then have received full ministerial recognition.

Colleges approved as "Colleges of Advanced Technology" are to concentrate on scientific and technological education at the highest level, and while funds have been provided by the government towards their rebuilding and expansion, some redistribution of students at the lower levelsof technological training may, accordingly, be necessary. Research is also to be encouraged and developed at Colleges of Advanced Technology and forms part of the declared policy of the Government in financing these institutions.

Local and Area Colleges will, therefore, in future have to assume some of the work hitherto undertaken by the Colleges of Advanced Technology, and the Regional Colleges will similarly be required to

intensify their teaching and develop their more advanced levels of technological instruction.

Regional Planning

As early as 1925 it was realized that the growth of technical colleges was leading to an unnecessary duplication of courses in the highly industrialized regions. This was particularly true in Yorkshire, and in 1928, as a result, the Yorkshire Council for Further Education was set up. The Council exercised a profound influence on technical education in Yorkshire from the moment of its inception, without, however, entering into the field of examinations.

Shortly after the enactment of the Education Act, 1944, a Select Committee was appointed to consider "Higher Technological Education and the respective contributions to be made thereto by Universities and Technical Colleges". The Committee, under the Chairmanship of Lord Eustace Percy, published its report in 1945. The report recommended the establishment of eight Regional Advisory Councils to cover England and Wales. These recommendations were adopted, with minor amendments, by the Ministry of Education and embodied in Circular 87, which was issued on 20th February 1946. The circular suggested the creation of nine Regional Advisory Councils for England, with a tenth for Wales and Monmouthshire, but wisely concurred with the report in that "all schemes of regional organizations need not follow one and the same pattern in all particulars". In Wales the function of co-ordination was entrusted to the Welsh Joint Education Committee.

The main functions of the Regional Advisory Councils are to assess the need for further education of all kinds within the region, to advise the authorities on the co-ordination of the efforts of the colleges in meeting that need, and to avoid overlapping and unnecessary duplication of courses.

A new and important duty has been imposed on the Councils, however, by Administrative Memorandum No. 545, which was issued by the Minister of Education on 1st March 1957. Under this memorandum, the Minister's approval is needed before local authorities can establish advanced courses, and all proposals for new courses of the types listed in paragraph 6 of the appendix to the memorandum must first be submitted to the appropriate Regional Advisory Council. The final decision for purposes of grant is made by the Minister through his regional representative, the regional staff inspector, who sits on the Council as an assessor. Local authorities are expected to adhere to a timetable in submitting courses to the Council, so that the situation in the region may be considered as a whole. In this way, it is hoped, regional co-operation will be further developed and strengthened.

Each Council has a number of advisory committees dealing with technical and commercial education for the industries to be found in the region. In constitution only the broadest pattern of uniformity can be discerned among the various Regional Advisory Councils, and each has its own peculiarities in composition and structure. In general, however, each Council consists of representatives appointed by the local Education Authorities, the universities within its area of operation, industry and commerce, the principals and teaching staff of establishments of further education within the region, and certain co-opted members.

The Percy Committee Report also recommended the establishment of Regional Academic Boards of Advanced Technology in the areas for which Regional Advisory Councils had been suggested, and this recommendation was likewise adopted by the Ministry of Education in the circular to which reference has already been made. These Academic Boards are associated with Regional Advisory Councils in ensuring close co-operation between the universities and technical colleges in the provision of advanced courses.

At the centre a National Advisory Council on Education for Industry and Commerce, which is largely representative of the regions, advises the Minister on national policy.

The Council was set up by the Minister of Education in 1948. It is reconstituted every three years, and consists of a chairman and twenty members nominated by the Minister, and fifty-two members nominated by the ten Regional Advisory Councils for Further Education in England and Wales.

Each Regional Advisory Council nominates members representing local education authorities, universities, the teaching staff of technical colleges, employers and employees in its region.

The functions of the National Advisory Council are:

(a) To keep under continuous review and to advise the Minister by means of reports and in other ways on the national policy necessary for the full development of education in relation to industry and commerce and particularly in regard to:

(1) The planning of new development, including national colleges,

(2) The expansion of existing facilities,

(3) The improvement of accommodation and equipment,

(4) The development of appropriate research in colleges,

(5) The methods of examination and certification of studies,

(6) The provision of scholarships and awards,

(7) The co-ordination of the work of the Regional Advisory Councils and Regional Academic Boards,

(8) Other matters relevant to or arising out of the foregoing.

(b) To maintain contact with industry and commerce and appropriate professional bodies.

Much has been achieved by these bodies towards the establishment of good relations between industry and the colleges and the stimulation of sound development. Clearly they must play an even greater part in the future if courses, particularly advanced courses, are to be organized on a firm and comprehensive basis and if adequate facilities are to be provided with reasonable economy in buildings and teaching staff.

Governing Bodies

The constitutions and functions of governing bodies in technical colleges vary considerably. In some colleges the majority of the governing body are drawn from industry and commerce, while in others the members are mainly representative of the local education authority itself. Some governing bodies, again, have executive as well as advisory powers, while others perform the latter function only.

It is considered desirable by the Government that in all colleges of further education the governing body should be representative of the various vocational, educational, and social interests in the community with which the students of that college are identified. The aim should be to secure a governing body which will reflect the interest and enjoy the support of the local community as a whole, and at the same time comprise in itself a body of men and women ready to give time and thought to creating a vital, distinctive and independent college tradition.

The importance of this factor in the future development of technological education has been emphasized on more than one occasion. In Circular 98 issued by the Ministry of Education in April 1946, it was stated, firstly, that all major colleges of further education should have strong governing bodies, particularly in having "adequate representation of important industrial and commercial interests and the universities, as well as of the local education authorities concerned", and secondly, that "subject to the ultimate control in matters of finance and general policy of the providing authority, the College should enjoy

such freedom as will enable the Governing Body to develop its work in such directions as prove desirable and to attract first-class teachers on to the staff".

Nevertheless, in 1953-54 an enquiry conducted by the Ministry of Education revealed that of 198 colleges surveyed, 136 had governing bodies which fell considerably short of the recommendations made in Circular 98. Many of these 136 governing bodies were but in effect sub-committees of sub-committees of the local authority concerned. Of the 62 colleges which were regarded as broadly complying with the requirements of the circular, only 32 colleges satisfied the conditions in full.

It is perhaps significant, therefore, that the Minister of Education now insists that in order to obtain recognition as a regional college or as a College of Advanced Technology a college must possess a governing body which is not only strongly and directly representative of industry and of the authorities who regularly contribute substantial numbers of students to the college, but of the universities and professional technological interests within the area which are also affected. The Minister attaches considerable importance to the establishment of advisory committees for each technology in the college. Such advisory committees consist of representatives of industry, the appropriate professional bodies, and the college staff, and are organized on a departmental basis, although responsible to the governing body.

Much remains to be done, however, towards the establishment of governing bodies in colleges of further education which will truly represent the ideals and conceptions of the Ministry of Education as an essential condition to the full and ultimate development of technological education.

Character and Range of Institutions

Technical colleges in England and Wales have usually developed in response to an existing local need. Only a few such colleges, which are estimated at 1 per cent of the total, have been planned in advance of existing demand or have involved more than the physical transference of classes and equipment from a technical school already in being to some newly constructed building which is to be known thereafter as a technical college.

A post-war example of a technical college which was conceived and planned in advance of a demand for technical education in the area is Hatfield Technical College. This College was established in 1952, under the governance of the County Council of Hertfordshire. It is an entirely new institution and is sited in a new building, with a catchment area of approximately ten miles radius in Mid Hertfordshire.

Most technical colleges, however, have developed over the years in response to the expressed or anticipated needs of the local industries which are affected and to the general requirements of the area in question.

Three main factors may be selected as contributing towards the establishment and siting of technical colleges throughout the United Kingdom.

First, geological and geographical considerations. The siting of technical institutions has largely depended on the nature and extent of the industry or commerce which is carried on in the area for which educational provision is intended to be made.

In coastal areas, for example, institutions tend to be either of the "port" or "seaside" type. The South Shields Marine and Technical College, with its main departments of Navigation and Marine Engineering, and ancillary departments of Electrical Engineering, Mathematics and Physics, is a typical example of a technical college which was primarily erected to meet the needs of shipping. Blackpool Technical College, on the other hand, with its two departments of Food Technology and of Hotel and Catering, is a college which depends very largely on the hotel and catering industries within its area and has the characteristics of a "seaside" college in almost every other respect.

The geographical distribution of the various coalfields in England and Wales has also contributed to the location and erection of technical institutions. Wigan and District Mining and Technical College and Coalville Mining and Technical College are but two illustrations of the numerous colleges which owe their existence, directly or indirectly, to the mining industry. In some cases the dominant mining interest which was the reason for the creation of such colleges has been later subordinated to other and more diverse functions. The Technical College and School of Art at Nuneaton, for example, which was formerly known as the County Mining and Technical School, now provides instruction in many subjects other than those which are directly related to the mining profession and which formed the basis of its original foundation.

Other important industries have also contributed to the erection of technical colleges in different parts of the country. The College of Technology at Sheffield and the Constantine Technical College at Middlesborough both owe their origin to the iron and steel industry. Separate Textile Departments exist at many colleges, such as at Bolton, Burnley and Manchester, to meet the needs of the cotton and woollen industries, while the Boot and Shoe Manufacturing Industry has two leading colleges which provide instruction exclusively in the processing of leather and its manufacture into finished goods. The National Leathersellers' College is concerned with the science and technology of producing finished leather from raw hides and skins, and is situated in London. The Cordwainers Technical College, which is also situated in

London, is concerned on the other hand with the use of leather in the boot and shoe, leather goods, and associated trades, and is a distinguished example of a monotechnic.

Second, problems of population. The density of population in towns and villages and their surrounding catchment area has likewise been an important factor in determining the siting of technical institutions. Dudley and Staffordshire Technical College is situated in a heavily industrialized area and cuts across both borough and county boundaries in the divisions of its work and the recruitment of students.

In the larger cities the concentration of industry and commerce has resulted in the establishment of separate colleges of various kinds, each of which is capable of maintaining work at a high level. In Liverpool, for example, there are separate Colleges of Technology, Building, Art and Commerce respectively; while in Leicester there is a College of Art, as well as a College of Technology and Commerce.

Third, transport facilities. Considerations of accessibility have had an important influence on the siting of many technical institutions. Indeed, most regional schemes of technical education which are in operation to-day will be found to coincide almost exactly with the radiating and inter-connecting transport arrangements which exist within the areas concerned.

Stretford Technical College, in Lancashire, is in effect a contributory technical college by reason of its geographical position and the transport facilities which are available to the public. It has a large volume of work up to Ordinary National Certificate or equivalent standard, but its students then proceed to the College of Technology at Manchester or the Royal Technical College at Salford.

Birmingham College of Technology, on the other hand, is a regional institution with a high concentration of advanced work in many technologies. It relegates its courses of Ordinary National Certificate or lower standard to a number of contributory colleges, all of which are situated either in Birmingham or in adjacent districts which are easily reached by public transport.

Affiliation with Universities

In a relatively few areas of England and Wales, technical colleges have affiliated with their local universities, and this arrangement has operated with considerable success. The measure of association which has been attained in this way between the two types of institution has naturally varied with the different educational conditions

of the areas affected, and ranges from recognition by the university alone of a single subject in the curricula of the technical college to the virtual incorporation of a department of the college in the university.

There are, however, three main ways in which technical colleges have affiliated with universities. These are known for convenience as the Manchester model, the Sunderland model, and the London model.

1. Manchester

The arrangement which exists between The Manchester College of Science and Technology, and the University of the same city provides an illustration of affiliation in its closest form. The College of Science and Technology constitutes the Faculty of Technology for the University in a wide range of subjects (including Mechanical, Electrical, and Municipal Engineering, Applied Chemistry, Textile Chemistry, Textile Industries and Building) and the Governing Body of the College includes representatives of both the local education authority and the University.

2. Sunderland

Sunderland Technical College provides courses up to a Final Pass standard for the first degree of Durham University in Mechanical, Civil, Electrical, and Marine Engineering. The senior members of the Technical College staff are given the status of "recognized teacher" in the University, while the College is represented on the University Senate by the Principal, and on the Board of the Faculty of Applied Science by the Heads of the Mechanical and Electrical Departments. No member of the Technical College staff may, however, serve on any Examining Board of the University.

Students who wish to take an Honours or Advanced Degree must either take the external examinations of London University or proceed for a fourth year to King's College, Newcastle.

3. London

Altogether seven different Technical Colleges and Polytechnics in the Greater London area are affiliated to the University of London.

Certain members of their staffs are "recognized teachers" of the university, and are entitled to prepare students for internal degrees on a part-time or full-time basis in the Faculties of Science, Engineering, and Music.

Recognized teachers in these institutions serve on the Boards of Faculties and Boards of Studies of the University, and they may also be included in Examining Boards.

Before the Senate of the University recognizes teachers in these institutions, it must, of course, be satisfied in regard to the government of the College, the accommodation provided, (including provision of equipment, laboratories, and facilities for research), the standards of instruction, and the general suitability and conditions of service of the staff in question.

In recent years, for a number of reasons, the universities have shown little desire to extend the existing affiliation arrangements either to include further technical colleges or to include a wider variety of subjects. Provision already exists, for example, at Leeds, Sheffield and Liverpool Universities for the affiliation of approved colleges and the recognition of technical college teachers, but the provision has been very little used. Huddersfield Technical College is affiliated to Leeds University for the first year of the courses leading to the degrees of B.A., B.Sc., (including Engineering) and M.B. and Ch.B., while Barnsley, Lincoln, Chesterfield, and Scunthorpe Technical Colleges are affiliated to the University of Sheffield in such a way that students may proceed to an Honours Degree in Engineering and Metallurgy at the end of a three-year, instead of a four-year course. But no technical college has as yet been affiliated to the University of Liverpool.

Sandwich Courses

Sandwich courses play an important and increasing part in the British system of technological education.

A "sandwich" course, as its name suggests, is a course which involves alternate periods of full-time attendance at a technical college with equal periods in industry for practical training.

It is the policy of the Government to foster and encourage the development of sandwich courses in every possible way. In the view of the Ministry of Education, as technologies grow more complex and the need for versatility increases, the strain of reaching high qualifications by evening work or by studies on one or two days a week becomes more severe. In these circumstances it is believed that for the highest technological qualifications sandwich courses will become more and more appropriate. Courses of the type envisaged will be of four to five years duration.

These advanced courses, it is considered, will suit the able worker who is already employed in industry, and should also attract an

increasing number of young boys and girls who, when they leave school at eighteen, feel the urge to start their careers at as early an age as possible.

The National Advisory Council on Education for Industry and Commerce has also considered the desirability of sandwich courses as a medium of technological education, and in February 1956, submitted a report on the subject to the Minister of Education.

Sandwich courses, the Report stated, were already in operation at a number of technical colleges and ranged from courses covering a period of two years, leading to the Ordinary National Diploma, to courses covering four to five years, leading to the Higher National Diploma and College Associateships.

In the view of the National Advisory Council, the professional type of sandwich course should normally cover a period of four to five years and should be of such a standard that it might be expected to satisfy the requirements for the new technological award which had been created.

The Council found evidence to show that periods of five months in the college and seven months in industry, or of about six months in each, were normally the most effective and convenient arrangement. It was important, however, in all sandwich courses that colleges should maintain contact with their students during their works periods. Such contact might take the form of tutorial classes or of guided studies.

It is, perhaps, significant that in the current List of sandwich courses approved by the Ministry of Education, the vast majority are based on alternate periods of six months duration, the first half-year being spent in full-time attendance at classes, followed by an equal period in industry. In most courses the equal division of the year between industry and the college has been found to be the best arrangement.

The list of colleges which provide sandwich courses in England and Wales is too extensive to be reproduced in this memorandum: and it may be sufficient to state that sandwich course arrangements are now applied to courses finishing at very different levels at many different technical colleges throughout the country.

At Portsmouth College of Technology, for example, there are five approved sandwich courses in operation. The course in Chemistry is of five years duration and leads to the award of Grad. R.I.C., while those in Electrical Engineering and Mechanical Engineering are of four years duration and lead to the Higher National Diploma. A parallel course in Electrical Engineering also extends to four years and leads to the College Diploma; while the course in Commercial Engineering is of three years duration and leads likewise to the College Diploma.

The advantages of sandwich courses as a medium of technological education are now widely recognized and may be summarized briefly as follows:

1. The student works in modern industrial plants and laboratories on a scale and standard which are far beyond the financial resources of any teaching institution to provide.

2. During his works periods, the training firm may assess the student's abilities and capacity for development far more accurately than is possible by a mere interview, even where coupled with a copy of his college record.

3. The student learns to work with all kinds of people under modern industrial conditions, and becomes familiar with job practices, skills, labour and plant operation in advance of his graduation.

Sandwich courses are, broadly, of two types, "works-based" and "college-based". In "works-based" courses the firm usually recruits students from schools with advanced General Certificate of Education qualifications, or recruits from its own apprentices who have gained the Ordinary National Certificate.

Works-based sandwich courses are best suited to an industry with well established training schemes and sufficient numbers of good day-release students to form the basis of a course in, for example, engineering.

In "college-based" courses students enter the college direct from school and are subsequently placed by the college with firms for their industrial experience. This kind of recruitment is especially advantageous to an industry which is composed mainly of small firms. It can give an increased intake of ability into the industry, and while employers have no financial commitment for the college period, they have an extended opportunity to see the work of selected students with a view to their future engagement. The college, too, can secure variety of industrial experience by placing students with different firms in successive works periods.

The sandwich student is normally paid his appropriate salary during his works period, irrespective of whether he is works- or college-based. In addition some firms undertake to pay the works-based student's college fees, and also to continue paying his full salary during the college period.

In the opinion of the Education Committee of the Federation of British Industries, while care must be taken not to permit a wasteful proliferation of these courses, the development of the sandwich course

system of technical education for selected students deserves the fullest support of industry.

The future development of sandwich courses in the United Kingdom depends ultimately, therefore, on the measure of co-operation which can be obtained between colleges and industry, but sandwich courses have already been or are being developed for the building, chemical, electrical, mechanical engineering, mining and railway industries, and similar arrangements for other industries will be vigorously encouraged by the Government.

The following table shows the increase which has occurred in recent years in the number of sandwich courses approved by the Ministry of Education and the students who have enrolled on such courses.

Year	Courses approved	Students enrolled
1953-54	45	993
1954-55	70	1,419
1955-56	103	2,327
1956-57	148	3,979
1957-58	200 (estimated)	5,000-6,000 (estimated)

National Certificates and Diplomas

National Certificate and Diploma schemes have been in operation in various branches of technological education for almost forty years. In 1921 the Board of Education (now the Ministry of Education) entered into discussions with the Institute of Mechanical Engineers in regard to the possibility of creating a higher qualification in engineering which might reasonably approximate to the standard of a university degree and yet be obtainable as the result of part-time study only. The result of these conversations was the creation of the first National Certificate scheme in mechanical engineering. The scheme from its inception was so successful that it has served largely as a model for all subsequent National Certificate schemes, whether in relation to mechanical engineering or to other departments of technology.

The National Certificate schemes which are now in operation throughout the country are intended for part-time, as distinct from full-time, students and are designed to secure a minimum national standard representing continuous part-time study over a period of five or six years from the age of sixteen or seventeen. An Ordinary National

Certificate is normally taken after three years' study, and a Higher National Certificate after a further two years. The Higher National Certificate is a qualification of approximately first degree standard in the subjects taken, although, being based on a part-time course, it is necessarily narrower in scope. Endorsements in respect of additional subjects may be awarded as the result of further study. It is common for students who have gained the Higher National Certificate to pursue their studies to a level which provides complete exemption from the examinations of professional institutions.

The National Diploma schemes are designed to set a similar standard for full-time students. An Ordinary National Diploma is awarded on two years' full-time study, usually started at the age of sixteen. The Higher National Diploma requires three years' study and covers approximately the same ground as a university degree course. The courses for the Higher National Diploma, being full-time, are much more broadly based than those for the Higher National Certificate. They have a wider scientific content and normally include subjects of a liberal nature. Moreover, they often cover the full academic requirements for exemption from the examinations of professional bodies, whereas holders of the Higher National Certificate must spend an additional year or two on extra subjects, such as, for example, works organization and administration, and, in some cases, further specialized technical study. Students usually enter the course direct from school at the age of seventeen or eighteen, or after a period of employment combined with part-time study.

National Certificates and Diplomas are awarded jointly by the Ministry of Education and the professional institutions concerned. A National Certificate or Diploma scheme is generally initiated by discussions between the Principal of a technical college interested in the possibility of setting up such a course and the Inspector of Education who is responsible for the area in which the college is situated. If the outcome of these conversations is some measure of agreement, the governing body of the college then applies through the Ministry of Education to the appropriate Joint Committee for approval of the proposed scheme. In order to obtain the approval of the Joint Committee, however, the proposed scheme must accord with the Rules of the Ministry of Education in regard to the branch of technology with which it is connected.

The following is a list of the National Certificate and Diploma schemes which are at present in operation, with the distinguishing numbers of the Rules which apply to each scheme:

Subject	Year of Introduction	Ministry of Education Rules Governing the Scheme No.
Mechanical Engineering	1921	106
Chemistry	1921	100
Applied Chemistry	1947	100
Electrical Engineering	1923	127
Naval Architecture	1926	105
Building	1929	
	Reconstituted	
	1948	101
Textiles	1934	102
Commerce	1939	
	Reconstituted	
	1951	104
Production Engineering	1941	106(P)
Civil Engineering	1943	107
Applied Physics	1945	114
Metallurgy	1945	111
Chemical Engineering	1951	122
Mining	1952	123
Mine Surveying	1952	123

While each of the schemes enumerated above has characteristics individual to the department of technology with which it is connected, the Rules of the Ministry of Education in regard to all schemes naturally affect such fundamental matters as the age and educational standard of entry to the course in question, the exemptions from these entry conditions, timetables, choice and sequence of courses, staffing arrangements and equipment and examination procedure.

The examinations at the end of the first (S.1) and second (S.2) years of study for an Ordinary National Certificate are set and marked by the staff of the college at which the course is conducted, without assessment. The examinations at the end of the third (S.3) year are, however, externally assessed. The examination papers are prepared in draft by the college staff, but on this occasion are submitted to Assessors appointed by the Joint Committee. Each Assessor scrutinizes his paper in order to determine its coverage of the subject and its standard of attainment in relation to the work of other colleges. If he is satisfied on these matters, the draft paper becomes an assessed paper acceptable to the Joint Committee. The scripts are marked by the college staff, and likewise submitted to the Assessors, who may alter the final results, as they consider proper, in the determination of national standards.

The National Certificate is awarded on a composite mark which is based on homework, classwork and laboratory work, as well as on the result of the assessed examination itself. Homework and classwork marks and examination marks must each reach 40 per cent of the possible; and the examination marks are weighted in the final assessment to form 70 per cent of the total marks, of which the student must gain at least 50 per cent.

The Higher National Certificate is awarded on a similar basis of assessed examinations at the end of the fifth (A.2) year, considered in conjunction with classwork and other records. College internal examinations only are required at the end of the fourth (A.1) year, although the papers may be assessed by arrangement with the Joint Committee in order to secure exemption from the examinations of the appropriate professional society.

In many schemes, therefore, success in the Higher National Certificate examinations secures exemption from related parts of the examinations of the professional institutions, and a student who has thus been partially exempted may obtain complete exemption from the remaining parts of the professional examinations by taking additional subjects which are "endorsed" on his Higher National Certificate. In this way he may become a graduate member of the professional institution in his chosen branch of technology, such as indicated by the designation "G.I.Mech.E.". After a few years in professional practice he may become eligible for the Associate Membership of the institution concerned, such as "A.M.I.Mech.E." or "A.M.I.E.E.". Finally, if he attains a position of some responsibility within his profession, he may be elected to full membership of the professional institution, with the right to designate himself, for example, as "M.I.Mech.E." or "M.I.E.E.". The acquisition of a Higher National Certificate, therefore, may lead eventually to the attainment of full professional status, even though by a more indirect and longer route than through the obtaining of a university degree.

The growth which has taken place since 1938 in the number of students who have qualified for Ordinary National Certificates, Ordinary National Diplomas, Higher National Certificates, and Higher National Diplomas, is shown below.

		1938	1957
O.N.C.		3,313	16,176
H.N.C.		1,137	8,796
	Total	4,450	24,972
O.N.D.		95	359
H.N.D.		37	489
	Total	132	848

"The Royal College of Technologists"

In 1950, the National Advisory Council on Education for Industry and Commerce published its first main report on "The Future Development of Higher Technological Education".

The report referred to the suggestion that technological universities of the type represented in the United States of America by the Massachusetts and California Institutes of Technology should be established in the United Kingdom. In the opinion of the Council, however, the establishment of a new university institution would not be in itself a sufficient alternative to the measures proposed in the later parts of the report.

The technical colleges of the United Kingdom represented a tradition and system of education, perhaps unique, and certainly not to be found either in the United States of America or in most countries on the continent of Europe. By the nature of their evolution, the technical colleges had in general adopted a less academic approach to scientific principles than that characteristic of most university training. This distinctive approach was, nevertheless, both sound and useful. It did not imply that the technical colleges were uninterested in fundamental science or that they should confine their attention solely to "the teaching of technique to technicians".

If, however, high level courses were to be further developed in technical colleges, some substantial inducement had to be offered to the student in the form of an award which would have both a national and an international currency. The existing system of awards was insufficient and unsatisfactory. Schemes of affiliation between universities and technical colleges were unlikely to be developed to any great extent in the near future; the London External Degree, although carrying a considerable prestige, was limited in scope to a few technologies, such as engineering, mining and metallurgy; and the qualifications of the leading professional institutions were "professional" in character and not of an equal content to a university degree.

For all these reasons, therefore, the report recommended the creation of a Royal College of Technology, which would be concerned both with awards and courses at the first degree and post-graduate levels, and with general educational functions of a wider nature. The awards of the college would not confer a professional qualification, but would be designed, at the first level, to provide an educational qualification comparable in value to a university degree and, at the second level, a qualification attainable after an advanced course of post-graduate study and/or research in a phase of technology. The national body would neither conduct examinations nor set syllabuses, but would approve the principal conditions for examinations conducted by the technical colleges, and,

having regard to the necessity for flexibility and experiment, moderate syllabuses and teaching arrangements so that a high general standard might be assured.

To ensure the proper discharge of its functions, the council thought that the national body must be an independent self-governing corporate body, uncontrolled by any department of government or any particular interest. It must be composed, at least as far as its governing body was concerned, of persons of the highest standing in the varied fields of technology, and sufficient representation must be provided of all the chief interests concerned to ensure full co-operation on a broad front. The first Award should be an Associateship (A.R.T.C.), the second Award should be Membership (M.R.C.T.), with Fellowship (F.R.C.T.), and Honorary Fellowship for those who further distinguished themselves in the field of technological education and research.

National Council for Technological Awards

Although the recommendations of the National Advisory Council on Education for Industry and Commerce in regard to the creation of a Royal College of Technology have not been implemented, some measure of progress in a somewhat parallel direction has been achieved by the erection of the National Council for Technological Awards which was set up by the Minister of Education in 1955.

The council is not an external examining body, but a body which ensures conditions of teaching and the arrangements under which the examinations of technical colleges are conducted. If these conditions are fulfilled, the council will recognize the college and the course concerned, and the diploma will be awarded to successful students at the end of their course.

In 1956 the council announced that it would grant for the time being a first award only, a Diploma in Technology. The diploma is denoted by Dip.Tech. (Eng.) for engineering and by Dip.Tech., for other technologies, and is awarded in two honours classes (first and second) and at a pass level. Courses for the new award are to be equivalent to an honours degree course in a British university. The minimum period of full-time study at a technical college must be three years, together with suitable industrial training over an aggregate period of at least one year, which must be completed by the end of the study course. Where the course is a sandwich one, at least four years' academic studies in a major technical college are required, including organized studies during the periods of practical training in industry.

The minimum age of admission to recognized courses is normally eighteen, and the standard of admission is that of the General Certificate of Education, with two appropriate subjects at advanced level and three

subjects at ordinary level, or a standard comparable to that of holders of good Ordinary National Certificates.

Shortly after the issue of its original announcement, the council set up Subject Panels to deal with individual technologies. Each panel consists of council members from technical college staffs, members of the council who are associated with professional institutions and industry, co-opted members, where considered necessary, to provide detailed information on the subjects of the course under consideration, and one of H.M. Inspectors serving as an assessor. In addition to the examination by a Subject Panel of the written application which a college must submit for recognition of a particular course, colleges are generally visited by members of the council. The object of the visit is to inform the council of the setting in which a course would be conducted, and the accommodation and equipment which would be available for each individual course, but it also enables members of the council to meet the principal of the college and his staff and to allow the latter an opportunity of explaining the arrangements for conducting the course more fully than could be set out in the written submission. The council's Boards of Studies then consider the reports of the Subject Panels and the visiting party, and make recommendations to the Governing Body of the Council, with whom the final decision rests.

By April 1958, the council had approved 9 full-time and 34 sandwich courses, while in February of the same year there were 1,360 students studying for the Diploma of Technology at 11 different colleges. The subjects of the courses covered most types of engineering, physics, metallurgy, various aspects of chemistry, applied biology, and mathematics in its application to technology.

Day Release Schemes

A remarkable increase has taken place in post-war years in the number of persons who are released by their employers for part-time education during their normal working hours, as a comparison of pre-war with more recent statistics clearly shows.

In 1939, for example, the number of workers so released was 43,000, while in the year 1956/57 over 417,000 employees (most of whom were under 21 years of age) were granted similar facilities. The increase is all the more considerable by reason of the fact that the minimum school-leaving age was raised from 14 to 15 by the Education Act of 1944, with a resultant loss to industry of personnel at its lowest age level.

Although some day-release courses are entirely vocational in character, in most courses one or more subjects of general education are included. The curriculum of the day-release course almost invariably includes English, very frequently Mathematics, or, at least, some aspect

of the subject under the guise of, for example, "Calculations", and sometimes Physical Education, Handicrafts, and Citizenship. The variation which exists in the content and arrangement of day-release courses is virtually inexhaustible.

Release for part-time study during working hours is normally granted over a period of three years, between the ages of 15 and 18, but within these age limits there are many variations in arrangement. Some employers grant release for one year only; others for two years. Some employers make continued day-release conditional year by year upon success in annual examinations; while others grant release only when the ability and determination of the worker in question have already been tested by his voluntary attendance at evening classes. In the engineering industry employers are prepared, as a general rule, to provide facilities for part-time study by day-release for an almost indefinite period, provided the arrangement yields some prospect of a fair return.

Most modern schemes for day-release provide the employee with leave of absence on one whole day of the week, but approximately the same effect is achieved under other schemes by releasing the worker for two half-days a week. A few firms allow their employees a half-day only in each week, while others release their workers for two whole days, one of which may be devoted to vocational training and the other to general education. In a relatively small number of industries, such as farriery and boatbuilding, it has been found convenient to give block release to apprentices for periods up to four weeks in duration in order that they may attend suitable residential courses.

A very large part of the vocational training required by the day-release schemes now in operation is provided by the Technical Colleges, although in the building and printing industries Arts Schools also conduct courses.

Courses of a non-vocational nature are usually, although not invariably, conducted by the local education authorities in premises owned and maintained by the respective authorities.

The main advantage of the day-release system of vocational education is, perhaps, that it transfers the burden of professional and craft studies to the day time and so lessens the strain that is imposed on young workers at a period when they are already undergoing great physical, psychological, and environmental changes.

Nevertheless, many employers still continue to make the inauguration of new release schemes dependent on their employees attending classes in their own time. Frequently a full day's release from employment must be matched by attendance at the Technical College on two evenings of the same week. Nearly two-thirds of the students now taking courses under the day-release system also attend evening classes, either voluntarily or as a

condition of their part-time day release.

In the words of the White Paper on Technical Education, which was presented to Parliament by the Minister of Education in February 1956, "Part-time day education, as compared with evening classes, is to be preferred both educationally in the short term and from the point of industrial efficiency in the long term. But the essential factor is the full co-operation of all concerned - education authorities in providing facilities, and both sides of industry".

Training Within Industry

An important part is played by industry in the provision of technological education and training in the United Kingdom. Many firms have established independent courses of training within their own premises in the crafts and skills which are appropriate to their industry, while in the larger industrial organizations training schemes have been erected on a more comprehensive scale, varying in intensity from technician to the most advanced levels and in duration from a few months to several years.

As a general rule, where instruction in one particular process or skill alone is required, or where the process is simple and repetitive in nature, the firm undertakes the training of its own workers. Induction training of this type is peculiarly suitable to the routine processes of mass production, and is rarely capable of being effectively provided outside the firm concerned.

In a few industries a number of small firms, each of which lacks the facilities of manpower and equipment necessary for the establishment of an independent system of training, have grouped together to provide courses for juveniles entering the particular industry. The Salford and District Textile Training Guild is an illustration of the collective factor in modern technological training. Eleven independent firms have here grouped together, in co-operation with the Cotton Board and the local technical college, to arrange induction courses in subjects of common interest to them all. The courses are conducted in separate premises which have been especially acquired by the group, and thus no part of the training takes place in the premises of any one member of the group.

The medium-sized or large-scale undertaking conducts the technological training of its workers, as a general rule, on a much wider basis. Some of the accepted methods of training in this connection are as follows:

1. Induction Courses

These courses vary widely in duration, but the usual period is from one week to six weeks. In some firms, however, such courses extend to three months.

The extent and duration of the training which is provided naturally depend on the nature of the work which is to be undertaken and the technicality of the processes involved.

2. Works' Schools

Many industrial undertakings now maintain their own Works' School, which is accommodated on their own premises. A full-time Head of the school is usually appointed, and such other full-time or part-time staff as are considered necessary.

In other cases the school, while likewise accommodated on the firm's premises, is staffed by teachers employed and loaned to the firm by the local education authority.

Some Works' Schools, such as the Works' School of The Bristol Aeroplane Company at Filton, are subject to inspection by the Ministry of Education and approved by the Ministry as efficient establishments.

3. Day Continuation Schools

In some districts Day Continuation Schools have been established by the local education authorities under the Education Acts of 1918 and 1921 with the voluntary support of the industrial undertakings within their respective areas. Under the Education Act of 1944 County Colleges are to be established by local education authorities by an appointed date, and such County Colleges when established will replace the existing Day Continuation Schools.

4. Training Centres

Many large industrial organizations have a separate Education Department, which is responsible generally for the training of all the firm's employees. The Education Department staffs and manages the Works' School, arranges training at all levels, from induction to post-graduation courses, and in many firms discharges a very wide variety of functions of an advisory and educational nature.

Modern industry, therefore, is responsible internally for the training of a large percentage of its own personnel and many training schemes within industry in co-operation with the universities and technical colleges attain the highest levels.

Apprenticeship

While the number of university graduates who have entered industry in recent years has increased beyond all previous experience, the normal method of gaining professional qualifications as a technologist is still that of a substantially full-time apprenticeship concurrent with part-time courses of study at a technical college in the evenings.

This system has certain advantages over a university course, although at the same time it suffers from a number of inherent defects.

There is the advantage, for example, that while the young worker is in his initial period of, say, six months' probation, he is given an insight into the industry which he proposes to enter in advance of his committing himself to it as a career. The training is thoroughly practical, moreover, and should he fail to attain the necessary qualification, he should be at least able to take his place as a craftsman or as a technician. A further advantage is that the young worker obtains a wide experience with workmen, foremen, and junior management, which he would not normally obtain if undergoing the usual type of university course.

There are, on the other hand, very definite difficulties in this method of obtaining a professional qualification. Some apprenticeship schemes are insufficiently thought out and much of the apprentice's time is wasted in so far as learning his trade is concerned. In other cases, the training is too slow and does not absorb the interest and abilities of the apprentice as he progresses through the various phases of acquiring practical experience. And in all such arrangements the need to attend evening classes at a technical college over a period of several years imposes a physical and intellectual strain which the relatively few can support.

Training for a craft through apprenticeship usually lasts for four or five years. It aims to give the apprentice a wide knowledge of the operations of the trade as well as specialized skill. Training thus consists primarily of practical instruction in the job under the supervision of an experienced craftsman.

The majority of apprentices who are released by their employers to take part-time day-release courses probably attend courses which have been designed and arranged by the City and Guilds of London Institute. The Institute was founded for the advancement of technical education by the Corporation and certain Livery Companies of the City of London, and, within the terms of its Royal Charter, is specially concerned with the application of all such branches of science and the fine arts as benefit or may be of use to productive and technical industries. The Institute has a Department of Technology which deals

mainly with the training of the operative, craftsman, and technician. It has a system of advisory committees, representative of industry and educational interests. It prepares schemes of syllabuses and examination arrangements for the training and certification of employees in all the basic industries. Certificates may be of Intermediate or Final level and in some industrial groups Full Technological Certificates are awarded. The Institute's certificates and awards are approved by the Ministry of Education and enjoy a wide currency, being valued by employers and employees alike.

While no statistics are available for the total number of young workers now employed in craft apprenticeship, it is known that the number has greatly increased since 1945 owing to the introduction of training schemes by many of the leading industrial organizations in the country.

There are, in general, three main types of apprenticeship arrangement which are designed to meet the needs of the intending technologist:

(a) The student apprentice may enter industry between the ages of 17 and 18 for a course lasting four years. The course combines an intensive works training with classes on a part-time release scheme leading to one of the National Certificate qualifications.

This type of apprenticeship is quite distinct from the ordinary trade apprenticeship which meets the needs of those leaving the secondary schools at the age of fifteen. Student apprenticeships usually cover a period of four years, during which the apprentice is given experience in various departments in accordance with a definite plan designed to equip the apprentice with a knowledge of the materials, tools and machines used, and of the technique and organization of the firm.

At least half the period of apprenticeship is usually spent in the workshops, the remainder of the time being spent in training in the commercial and drawing offices. As a general rule the apprentice stays about twelve weeks in each department, so that he may obtain a sufficient grasp of the work of that department, without necessarily obtaining the detailed skill which is essential to a craftsman. In the closing stages of his apprenticeship, the apprentice may be given an introduction to the problems of production control, design and office administration. It is a common practice to arrange that the apprentice shall spend twelve weeks in the drawing office on work related to that on which the apprentice has specialized.

(b) Pre-graduate apprenticeship consists of practical training for one year before entry to a full-time course at a university or major technical college and another year after the completion of the academic course. The apprentice may also be required to train during vacations. Although not yet widely in practice, the pre-graduate apprenticeship is gaining popularity in the engineering industry.

The preliminary year's training has the great advantage of acting as a probationary period during which the apprentice may discover his aptitude or otherwise for the industry in question. The industrial experience which he acquires is also valuable in giving greater significance to his later academic studies, enabling him to relate the theory that he learns in the classroom with its practical application in workshops and laboratories. A further advantage is that the two periods of apprenticeship at different ages and with different outlooks give the apprentice two different relationships with workpeople and staff.

(c) The graduate apprentice may enter industry on three or six months' probation after he has completed his academic course. He then enters on a two years' works training to become acquainted with practical problems. He is expected at the same time, although in some firms this is not insisted on, to attend special lectures at the local technical college and on the works premises, to keep abreast of recent developments.

In general, therefore, the period of apprenticeship is shorter than with trade apprenticeships, as the university graduate is assumed to be more mature and to be able to make more rapid progress.

The first period of graduate apprenticeship is usually spent in the workshops obtaining a basic mechanical training, the remainder being spent in the offices and administrative departments.

Examples of Apprentice Training Schemes

The General Electric Company offers graduate schemes of training for university graduates in engineering and science.

The graduate schemes consist of two years' practical training. In the first year the graduate gains general engineering experience in the works and in the second year he specializes in his particular sphere of interest, such as research, development, production, installation or sales.

The same undertaking also offers a two-year university sandwich scheme, which provides a pre-university year in basic engineering practice, and a second year's training, after graduation, in more specialized aspects of the industry, such as design or production.

The ordinary student sandwich scheme provides for a course extending to five years, which is divided into periods of six months spent alternately in full-time study at a college of technology and in industrial training with the firm. The complete apprenticeship gives exemption from the practical training and educational requirements of the appropriate professional engineering Institutions, such as the Institution of Electrical Engineers, and thus at the end of his course the successful student is well on his way to professional status. To qualify for entry to this scheme students must be 18 years of age or over and have passed the General Certificate of Education in one or more subjects at the advanced level, and in a number of subjects, including mathematics, physics and English, at the ordinary level.

The British Thomson-Houston Company operates a very similar range of apprenticeship schemes.

Graduate apprentices are taken for a two-year course of practical training, although most apprentices now enter on a sandwich course.

In a variety of sandwich courses the Company co-operates with certain universities by providing one year's basic practical experience before a three-year university course, with a subsequent year under Graduate Apprenticeship conditions to complete the sandwich.

Student sandwich courses are run in co-operation with the Rugby College of Technology and Arts. The five-year sandwich course brings the successful apprentice to the level of a university honours degree by way of six-month periods, spent alternately in works and college, starting in the works and finishing in the college.

Other student apprenticeship schemes within the same undertaking provide for a preliminary year's works training combined with college study, followed by a four-year sandwich course leading to a College Diploma and professional qualifications. Apprentices who show particular aptitude in their studies may be transferred to the five-year course.

Provision is also made for technician apprentices. The minimum age of entry to this type of apprenticeship is 16, while the apprenticeship itself is of five years duration. During that time the apprentice is given both general and specialized training in the works, combined with part-time day and evening attendance at college.

NATIONAL COLLEGES

In a few relatively small and specialized industries, National Colleges for technological training have been established by the Government. There are now seven such colleges in the United Kingdom. In each case the object of the Government has been to provide highly specialized training in a single industry, which is highly dispersed throughout the country and employs comparatively few personnel, or the techniques of which are used in many other industries.

The educational requirements for admission as a student to these institutions naturally vary with the branch of technology to be studied, while the courses themselves inevitably differ in intensity and in scope of subject.

The following particulars give some indication of the work carried on at these institutions.

National College of Horology

This College was set up in 1947 by the Ministry of Education in association with the various trade and other interests concerned. It provides a three-year full-time course which leads to a Diploma in Horology. General subjects such as mathematics are taught to the standard of Part I Final Degree in Engineering, while in specialized subjects a slightly higher level is attained. Entry to the course is either direct from school or from the industry, and the course involves practical experience in a suitable industrial organization, as well as full-time attendance at classes for the major part of the academic year.

National Foundry College

Founded in 1947, the College provides a Diploma Course which consists of six months' college instruction, then six months' industrial experience, followed by one full academic year at the college. The standard of entry is either a Higher National Certificate in Metallurgy, Engineering or Chemistry, or a City and Guilds of London Final Certificate in foundry work, metallurgy or other approved subject.

The college also provides facilities for post-diploma study and training in research, as well as short courses.

The National College for Heating, Ventilating, Refrigeration and Fan Engineering

Established in 1948, the College provides for two full-time national courses, a diploma course and an associateship course, as well as various regional courses and local part-time courses.

The diploma course lasts one year, and the diploma itself carries exemption from the examinations for the Associate membership of the appropriate professional bodies. The college associateship course is a post-graduate one and takes at least one academic year.

The National College of Rubber Technology

The College, which also was founded in 1948, provides a three-year full-time course for its associateship (A.N.C.R.T.) and the associateship of the Institution of the Rubber Industry (A.I.R.I.). A one-year full-time course leads to the licentiateship of the College (L.N.C.R.T.) and the licentiateship of the Institution of the Rubber Industry (L.I.R.I.).

Full-time and part-time research may be undertaken towards the M.Sc., and Ph.D., degrees of London University, and simultaneously to the Fellowship of the College (F.N.C.R.T.).

The National Leathersellers' College

Formed in 1951 out of the Leathersellers' Technical College which had been built and equipped in 1909 by the Leathersellers' Company, the National College now awards a diploma to students who have completed a two-year full-time course at the college and to specially qualified students who have completed a one-year course.

A further specialized year of study leads to the associateship of the college (A.L.C.).

The associateship may also be awarded to students who have followed up the diploma with a third year advanced course and to graduates who have written a thesis on original research work undertaken at the college. Shorter courses are, of course, also available.

The National College of Food Technology

The College was set up in 1951, and provides training in the basic sciences connected with foodstuffs and their processing, in food engineering, quality control and industrial management.

A two-year full-time course in General Food Technology is offered to those engaged in the industry and other suitably qualified applicants who wish to enter it. The educational entrance requirements are G.C.E. Ordinary Level in four subjects and Advanced Level in at least one science subject, such as chemistry, physics or biology.

The National College also provides regional courses of training for masters and all others engaged in the meat, fish, fruit, vegetable and milk trades.

Post-graduate courses of one year are offered in applied microbiology, food quality control and general food technology.

The College of Aeronautics

The College was established in 1946 to train aeronautical and production engineers and scientists for the aviation industry, research, the Services, and learned institutions. The five main departments of the college are associated respectively with aerodynamics, aircraft design, aircraft propulsion, aircraft electrical engineering, and aircraft economics and production.

The main college course, which covers six terms spread over 20 months, is for students of graduate standard, and about half the students are, in fact, graduates or have a Higher National Certificate.

Intensive short courses are frequently held for special subjects, and research is encouraged in every possible way.

U N I V E R S I T I E S

There are seventeen degree-giving, self-governing universities in England and Wales, four in Scotland, and one in Northern Ireland.

The sixteen English universities are, in order of foundation:

Oxford and Cambridge	(12th century)
Durham	(1832)
London	(1836)
Manchester	(1880)
Birmingham	(1900)
Liverpool	(1903)
Leeds	(1904)
Sheffield	(1905)
Bristol	(1909)
Reading	(1926)
Nottingham	(1948)
Southampton	(1952)
Hull	(1954)
Exeter	(1955)
Leicester	(1957)

There is, in addition, the University College of North Staffordshire at Keele, near Stoke-on-Trent, which was established in 1949. This University College is empowered to award its own B.A. degree after a four-year course, comprising three years of degree studies in two principal subjects, preceded by a year of foundation studies. It is wholly residential.

Types of University

The British universities do not conform to a single pattern. They came into existence at a number of different epochs in response to the changing social and economic needs of their particular times, and each to-day has its own characteristics and its own history.

Although it is the universities themselves which grant degrees and lay down the conditions under which they shall be awarded, the focus of academic life at Oxford and Cambridge still lies in the colleges. Normally, indeed, it is only by being a member of a college that a student can become a member of the university. During some part at least of his university course he resides in college; he dines regularly in the college hall; and the private "tutorials" which he attends in college are a very important element in his education.

The newer or "civic" universities in the large cities, on the other hand, with the exception of the Durham Colleges which were founded on the model of Oxford, do not have a system of collegiate life such as exists at Oxford and Cambridge. About 32 per cent of their full-time students live sufficiently near to travel daily from their homes to the university, and 46 per cent live in lodgings for which, in general, they make their own arrangements. For the remaining 22 per cent, however, halls of residence are provided by the university and controlled by a warden who is usually a member of the academic staff. The focus of academic life is thus the university itself. The role which is played by the colleges at Oxford and Cambridge in providing a background of social, as well as of cultural life, is played in other universities by the Student Unions or Guilds to which almost every student belongs. Under the general supervision of the university, the students are entrusted with the full management of their Unions.

The Universities and the State

Although British universities receive a very large measure of financial aid from the State, neither the Ministry of Education nor any other government department has any jurisdiction within any of them or control over them. The universities are entirely autonomous in government and administration. They establish their own courses of study, award their own degrees according to their own regulations, admit only those students whom they consider it proper to admit, and appoint professors and lecturers at their own discretion.

Grants to the universities are not made directly by the Treasury to each individual institution, but are allocated out of a block sum voted by Parliament and administered by a body known as the University Grants Committee. The Committee visits different universities from time to time and, in the light of information thus obtained and of the estimates submitted to them by each university, makes recommendations to the Treasury as to the amount of money which is required to maintain the universities over a five-year period. The sum voted by Parliament is then allocated by the Committee among the individual universities, leaving it to the universities to expend their grants in the way which seems to them best suited to their needs. The University Grants Committee is also responsible for administering annual sums granted by Parliament for new buildings and equipment.

In recent years the amount of the financial assistance given by the State has increased enormously, and between two-thirds and three-quarters of the annual recurrent expenditure of the universities now comes from the Treasury.

Departments of Study

The courses of study which the universities provide are usually classified as arts, pure science, medicine and dentistry, technology, agriculture and forestry, and veterinary science.

The arts faculties have a very wide scope in subject-matter and include departments and schools of classics, philosophy, divinity, history, modern languages and literature, law, economics, geography, social science, and commerce. Altogether 43 per cent of the entire student body in Great Britain attend classes in the arts faculties. In several universities at least some of those fields of study, such as divinity, law and economics, are organized as separate faculties.

The faculties of pure science include physics, chemistry, botany, zoology, and many other forms of associated discipline. They account for 22.5 per cent of the student body.

Courses in the specialist forms of applied science which include medicine, dentistry, agriculture, forestry and veterinary science, are attended by 20 per cent of the student body, while the remaining 14.5 per cent are studying technology. It should be remembered, however, in this connection that technological training is given at an advanced level in many institutions which are not classed as universities.

Degrees in Technology

A considerable variety of nomenclature is employed by the universities in Britain to designate the various degrees which they confer in the field of technology.

In most universities the completion of a three-year or four-year course of full-time study leads to the award of a first degree.

This first degree may be variously styled but it is usually a Bachelor of Science (B.Sc.) degree except at the universities of Oxford and Cambridge where a Bachelor of Arts (B.A.) degree is awarded.

Several universities, on the other hand, name their degrees after the particular branch of technology which has formed the main subject of study throughout the course concerned. Thus, the University of London awards a number of different degrees in technology, including the Bachelor of Science in Chemical Engineering (B.Sc. (Eng.) (Chemical Engineering)) degree, the Bachelor of Science in Mining Engineering (B.Sc. (Eng.) (Mining)) degree, and the Bachelor of Science in Metallurgy (B.Sc. (Eng.) (Metallurgy)) degree, as well as in other specialized branches of technology.

Other universities, again, either incorporate the work "technology" in full in the designation of the degrees which they confer, or at least embody a recognized abbreviation of the term in the titles of the degrees which they award. The Universities of Manchester and Sheffield, for example, both award a Bachelor of Technical Science degree, with the authorized abbreviation of B.Sc. (Tech.).

The whole apparatus of university degrees in the United Kingdom is, however, so complex that reference to the official handbooks of the individual universities is essential to secure an accurate and comprehensive statement of the various awards and degrees which are conferred.

Departmental Structure

While all the universities of the United Kingdom, with the exceptions of Exeter, Hull, Leicester and Reading, may grant degrees in engineering, not all universities have the same facilities for specialized instruction in technical science as exist, for example, at the University of Birmingham.

Altogether eighteen of the twenty-two universities in the United Kingdom have separate Departments of Engineering for the study of civil, mechanical and electrical engineering. Separate Departments of Metallurgy exist at the Universities of Birmingham and Sheffield to serve the needs of the adjacent steel industry. At Glasgow, Liverpool, Belfast, Newcastle and Southampton, where there are large shipbuilding interests, the universities have specialized departments in naval architecture and marine engineering. The University of Leeds has specialized in courses and research in connection with the wool textile industry, including colour chemistry and dyeing. Leeds is the only university to offer courses in the chemistry of leather manufacture, while Manchester is correspondingly unique in its specialization in paper technology and Sheffield in glass technology. Universities, therefore, in the same way as technical colleges, have tended to specialize in studies which are closely related to the needs of their local industries.

In some universities, although by no means in all, separate faculties, as distinct from separate departments, have been created in Engineering or in Technology. Thus, in the University of Sheffield there is a Faculty of Pure Science, a Faculty of Engineering, and a Faculty of Metallurgy.

In general, however, most of the departments which are included in such a Faculty of Engineering or of Technology are to be found in the Faculty of Science at the average university. Thus, in the University of Birmingham there are no separate Faculties of Engineering or of Technology. The appropriate faculty for technological education is that of Science. Nevertheless, within this faculty there is a very high degree of specialization in the leading branches of technology.

The following list of departments which are included in the Faculty of Science at Birmingham University demonstrates the intensity of the specialization which demarcates this particular faculty:

(1) Pure Mathematics
(2) Mathematical Physics
(3) Physics
(4) Electron Physics
(5) Chemistry
(6) Zoology and Comparative Physiology
(7) Botany
(8) Microbiology
(9) Geology (with Mineralogy and Geophysics)
(10) Mechanical Engineering
(11) Engineering Production
(12) Civil Engineering
(13) Electrical Engineering
(14) Chemical Engineering
(15) Malting and Brewing and Applied Biochemistry
(16) Physical Metallurgy
(17) Industrial Metallurgy
(18) Mining
(19) Genetics

In the University of Reading, on the other hand, technological education is divided between two faculties, the Faculty of Science and the Faculty of Agriculture and Horticulture.

The Faculty of Science consists of nine Departments:

(1) Mathematics
(2) Physics
(3) Chemistry
(4) Botany
(5) Zoology
(6) Geography
(7) Geology
(8) Microbiology
(9) Psychology

The Faculty of Agriculture and Horticulture includes the following Departments:

(1) Agriculture
(2) Dairying
(3) Horticulture
(4) Agricultural Chemistry
(5) Agricultural Botany
(6) Biochemistry
(7) Microbiology
(8) Veterinary Science
(9) Veterinary Hygiene
(10) Agricultural Economics

A considerable degree of divergence exists, therefore, within the field of technological education both in the departmental structure of individual universities in the United Kingdom and in the content matter of the courses which they respectively provide.

University Grants Committee

In 1950 the University Grants Committee prepared a "Note on Technology in Universities" which outlined their proposals in regard to the future development of technological education in the universities.

While the Committee admitted that there might be some degree of overlapping in the functions of the universities and of some technical colleges, they considered that the distinctions between the technology proper to universities and that of the technical colleges ought to be

recognized more clearly in planning further changes. Certain aspects of technology or applied science were well suited to university study. The difference between the two types of institution was not in status or grade, but in kind. The work of a university in technology should be much more closely related to fundamental science or other relevant studies than that of a technical college. In general, the courses should be more widely based on higher standards of fundamental science and contain a smaller element of training related to immediate or special work in industry.

The establishment of more post-graduate courses of one or two years duration was wanted, among other things, to advance technological education in the universities. University graduates requiring the more specialized courses might go, as a number did at the time of the Note, to certain technical colleges, and presumably the universities would be willing to admit to their post-graduate courses suitably qualified students from the technical colleges.

Developments in the universities on the lines discussed in the Note would, in the words of the Committee, "leave for the technical colleges a large and expanding field of work of great importance".

Comparative Statistics

In 1954 2,800 University Degrees and Diplomas were granted by the universities in Great Britain in the engineering and other applied sciences. This figure represented 57 per million of the population of the country. In the same year 8,110 Higher National Certificates or equivalent qualifications were awarded, representing 164 per million of the population.

Approximately 2,300 of the total number of graduates obtained their degrees by full-time study at universities, while the other 500 attended classes, full-time or part-time, at technical colleges.

The number of graduates in pure science produced in Great Britain represented 105 per million of the population.

For the whole of Western Europe the comparable figure was 48, for the U.S.S.R., 56, and for the U.S.A., 144. In technology Britain's figure was 57 graduates per million population, compared with an average of 136 for the U.S.A. and of 67 for Western Europe, including France (about 70), Switzerland (82) and Italy (39). In addition, some 164 per million of the population of Britain obtained qualifications from technical colleges, of which number perhaps half were the equivalent of university graduates in technology in the U.S.A. .

The Annual Report of the Advisory Council on Scientific Policy for the year 1956-57 shows that in 1956 the estimated output of qualified scientists and engineers was just under 11,700, this figure being made up as follows:

University degrees and diplomas in pure science	4,990
University degrees and diplomas in engineering	2,350
Estimated admission to graduate or associate membership of professional Science Institutes of scientists not having a university degree (mostly holders of Higher National Certificates or Diplomas, trained at technical colleges)	170
Estimated admission to graduate or associate membership of professional Engineering Institutions of engineers not having a university degree (mostly holders of Higher National Certificates or Diplomas, trained at technical colleges)	4,175
Total	11,685

S C O T L A N D

In general, what has been said in regard to technological education in England and Wales applies equally in Scotland.

In Scotland, as in England and Wales, boys and girls may leave school at the age of fifteen and thereafter pursue part-time studies up to an advanced level comparable in many respects with that of a university degree. Those who complete a full secondary course, and consequently leave school at the later age of seventeen or eighteen, can proceed forthwith to full-time courses for a degree or comparable qualification or can enter part-time courses at technical colleges at a higher level.

The part-time qualifications which form so important a feature of technical education in England and Wales, such as the National Certificates and the awards of the City and Guilds of London Institute, play an equally important part in Scotland.

The essential difference between England and Scotland in the field of technological education, therefore, does not lie in any divergence of methods or approach to the problems of modern technical training but in the evolution and structure of the contrasting educational systems which have been established in the two countries.

Secondary Schools

Pupils normally transfer to secondary courses about the age of 12, a year later than in England.

These courses are of two main types. The junior secondary course extends to three years and is designed for pupils who intend to leave school at the age of fifteen. The senior secondary course extends to five or six years and normally leads to presentation for the Scottish Leaving Certificate.

Junior secondary courses correspond roughly with those provided in Secondary Modern Schools in England, while senior secondary courses are broadly equivalent to those provided in Grammar Schools and Secondary Technical Schools in England.

While the junior and senior secondary courses are primarily designed to provide a good general education, both types of course also include technical subjects. Almost all the boys in the junior secondary courses study some science and mathematics and receive some training in craft work or technical subjects.

The Scottish Leaving Certificate is normally taken at the age of 17 or 18, on the completion of the senior secondary course, in a fairly wide range of subjects which very often includes mathematics and science and may include technical subjects. Boys frequently proceed to university or to some other form of full-time education immediately after gaining the Certificate.

The great majority of girls and boys in Scotland, therefore, study science and mathematics for at least three years, while the number who are taking these subjects up to the level of the Scottish Leaving Certificate has steadily increased in recent years. In 1954, among the twenty-five optional subjects of examination, English had 8,499 candidates, while Mathematics had 7,418 and Science 4,861.

Central Institutions

In Scotland technical education in its higher forms is mainly provided by the Central Institutions. These institutions function on a regional and, in certain cases, on a national basis, and provide the most advanced forms of instruction. They have independent governing bodies which represent the leading industrial, educational and other public interests in the region.

There are sixteen such institutions in Scotland. Thirteen of these were recognized as central institutions between 1901 and 1909, while of the remainder the Scottish Woollen Technical College, Galashiels, was recognized in 1922, the Royal Scottish Academy of Music, Glasgow, in 1938, and Paisley Technical College in 1950.

Seven of the Central Institutions are directly concerned with the teaching of technical subjects. These institutions are:

Robert Gordon's Technical College, Aberdeen;
Institute of Art and Technology, Dundee;
Heriot-Watt College, Edinburgh;
The Scottish Woollen Technical College, Galashiels;
The Royal College of Science and Technology, Glasgow;
Nautical Training College, Leith;
Technical College, Paisley.

These colleges offer courses in a wide range of subjects, including the sciences, pure and applied, and the technologies which are related to industries such as engineering in all its branches, building, printing, baking, brewing, woollen manufacture, and shipping.

The full-time courses of the technical colleges are of three or four years' duration, and mainly lead to the College Diploma or Associateship, which is comparable in scope and standard with a university

degree. Age and qualifications for entry to the courses are usually similar to those for entrance to a university, except that a foreign language is not essential. In addition courses may be provided for external degrees of London University and for the Higher National Diploma.

The highest awards of the two leading Central Institutions - The Royal College of Science and Technology, Glasgow, and the Heriot-Watt College, Edinburgh - are now recognized as being of honours degree standard.

The Royal College of Science and Technology, Glasgow

(a) B.Sc. Degree

The Royal College of Science and Technology is the most advanced technical college in Scotland. It has the largest school of technology of university standard in the United Kingdom, and is regarded as one of the leading establishments for higher technological education.

By an Ordinance of the University Court of the University of Glasgow, which was approved by His Majesty in Council in 1913, the Royal College of Science and Technology became affiliated to the University of Glasgow. An Advisory Committee was established, and Joint Boards of Studies in Applied Science and Architectural Science, with Boards of Examiners, representing the University and the College, were constituted in accordance with the regulations laid down in the Ordinance.

The College provides complete courses leading to the B.Sc. degree of Glasgow University in civil engineering, mechanical engineering, electrical engineering, mining engineering, chemical engineering, applied chemistry, metallurgy, architecture and pharmacy. The full course for a degree extends over four years.

Students who attend a course at the College for B.Sc. degree of Glasgow University must matriculate at the university, and are then entitled to all the privileges of matriculated students who are pursuing courses of study in the university itself.

(b) Associateship

The Associateship of the Royal College of Science Technology (A.R.C.S.T.) is awarded in the following branches of Applied Science: Mechanical Engineering, Civil Engineering, Chemical Engineering, Electrical Engineering, Mining Engineering, Naval Architecture, Applied Chemistry, Metallurgy, Ceramics, Pharmacy, Food Science, Microbiology, Applied Physics, Applied Mathematics, Building Technology, Textile Technology.

The Associateship may be awarded with first class honours or with second class honours or at the ordinary standard.

The curriculum normally extends over four academic years and may include the preparation of a thesis or a report on a scientific investigation carried out by the student.

The Associateship with honours is recognized as equivalent to an honours degree, among many other different types of institution, by the Civil Service Commissioners for employment in the Scientific Civil Service, by professional societies as regards exemption from their own examinations, and by many universities as a qualification for proceeding to a higher degree.

Heriot-Watt College, Edinburgh

An Ordinance of Affiliation also exists between the Heriot-Watt College and the University of Edinburgh.

Under the terms of affiliation, the university recognizes the college courses for its B.Sc. degree in mechanical and electrical engineering, chemical technology and mining.

The college provides three-year courses leading to its Associateship in mining engineering and brewing, and four-year courses leading to its Associateship in mechanical engineering, electrical engineering, civil engineering, applied chemistry, applied physics, applied pharmacy and chemical engineering. The Associateship in the four-year courses may be awarded with first or second class honours or on a pass standard.

Further Education Centres

As a counter tendency to the original regionalization of technical education in the Central Institutions, various education authorities have in recent years developed technical colleges within their own areas, which, in effect, have relieved the Central Institutions of much of their elementary work.

Some sixty further education centres, including technical colleges and other day institutes, have been established in this way, the main expansion having taken place since 1940.

These local technical colleges complement what is done in the Central Institutions by conducting courses for Ordinary National Certificates and, in some cases, Higher National Certificates, the

certificates of the City and Guilds of London Institute, and courses of a practical craft and workshop nature.

They also provide full-time pre-apprenticeship or pre-vocational courses to prepare boys and girls who have left school at the age of fifteen for the trade they wish to enter. These courses, in general, last one year, the time being divided equally between subjects of general education, the fundamentals of technical subjects, and practical work. They cover a wide range of occupations, including building and engineering.

The Technical College at Coatbridge, Lanarkshire, for example, provides a variety of Trade Courses in Mechanical Engineering which are suitable for students who propose to enter or have just entered industry, either by way of attendance at day or evening classes.

National Co-operation

In 1949 the Secretary of State set up five Regional Advisory Councils for Technical Education in Scotland. Their function is "to advise education authorities and other managers of educational establishments in the region ..... as to the development of technical education or any branch thereof for persons who have left school".

Regional Advisory Councils in Scotland broadly follow the constitutional pattern of Regional Advisory Councils in England. Each Council is composed of representatives of employers and employees, education authorities and educational institutions (universities, teacher training colleges, further education centres, central institutions and secondary schools) in the region.

The Councils have since their inception done much valuable work in examining various aspects of technical education in their regions and have issued useful memoranda and reports on a variety of subjects.